was grown on a fairly small acreage in hilly areas. Where it was felt that corn had to be grown it was kept out of the rotation as long as possible.

These points indicate that most farmers in the area were aware of the hazards in cultivating the highly erosive slopes. They tended to choose crops accordingly. On the other hand, erosion attributable to the tillage and harvesting methods of the time, like thorough plowing, cultivation and residue removal after harvesting were not fully understood.

Information on crop rotations varied considerably among the soil survey and other literature. Some sudies gave no information on the rotations follwed. However, one rotation commonly mentioned as widely practiced was one year of corn (C), followed by a year in oats or other small grain (G), followed by a year of meadow (M), with the meadow being seeded in with the oats, or CGM. A second fairly common rotation was CCGM.

Corn was seldom grown continuously and then only on the best land or on small tracts on hill farms. Several soil surveys indicated that systematic rotations were not commonly practiced, but the meaning of 'systematic' was unclear. Rotation meadow was usually cut for hay until turned under, but was sometimes used as green manure in years of abundant rain and other hay. Many farmers were said to feel from experience that long rotations involving meadow could not be carried out successfully. Hay was left in as long as possible as forage. Farmers preferred cash crops like tobacco and corn over hay.

Rotations involving corn were generally limited to the smoother lands and not put on the hilly sections because of the difficulty in cultivating steep slopes as well as their susceptibility to erosion. The somewhat uneven and scattered information on rotations common in MLRA 105 in the 1925-35 period leads one to conclude that the most common rotation involving corn was CGM (C=corn, G=any small grain, M=meadow). The Crawford County Soil Survey indicated that rotations on the relatively level valley soils frequently alternated corn only with meadow, such as CCMM or CCCMM. Corn was avoided on fairly sloping ridgelands, with small grains, mainly oats, alternated with meadow, as in GGM or GGMM.

There was evidence in some reports that the failure to follow crop rotations led to serious weed problems. Check-row planting of corn was practiced for weed control and improved water absorption, but the necessary partial cultivation with slope tended to aggravate erosion problems, especially during the early cultivations.

Soil Management Problems

Commercial fertilizers were not commonly regarded by farmers as being necessary for profitable production, and liming was not generally practiced. An important exception was Crawford County where limestone quarries were nearby and commercial fertilizer was used five sample counties were: 64 percent harvested for grain, 26 percent cut for silage or fodder, and 10 percent hogged off.

Harvesting of Small Grains: For small grains like oats, wheat, barley and rye, other than the acres occasionally cut early for hay, the common practice was to harvest for grain, and remove the straw, leaving only the stubble. Combines were not yet marketed in the area. The small grains were generally cut with binders, shocked, and centrally threshed, probably on a custom or cooperative basis, and most likely in the fields or near the buildings. The straw stacks may have been used directly or baled and then stored or sold. In any case, the fields were left as stubble and fall-plowed as soon as possible, if not already seeded to meadow.

Conservation Efforts

Common conservation techniques like contouring, terracing and strip cropping were seldom practiced in MLRA 105 prior to the establishment of Federal and State technical assistance and cost-sharing programs. However, it appears that farmers of the time generally did avoid cultivating their highly erodible land. Cropping patterns were determined largely by soil and slope conditions, within the needs of the farm for grain and forage crops. The soil survey reports for both Crawford and Trempealeau counties in Wisconsin indicate that there was little cultivation on slopes exceeding 14 percent. On the other hand, because of their tendency to lodge under excellent growing conditions, small grains like barley and oats were not commonly grown on the level well-drained soils

The Coon Creek project report involving parts of Vernon, La Crosse and Monroe counties in Wisconsin relates that two farmers in the area had terraces. Both systems had been established with the help of the Extension Service. The terraces were small but effective and natural grass waterways were used for outlets. The value of terraces for erosion control was recognized by both the owners of these two farms and their neighbors.

erosion and associated treatment needs and practices. The NRI estimates for 1992 were based on observations at about 800 thousand randomly selected sample points located across the United States. Results are judged to be statistically reliable at a national level and for States, broad regions, and sub-State areas other than individual counties. National-level results for 1992 are summarized by Kellogg and associates (Kellogg, TeSelle and Goebel, 1994). A review of USDA's similar inventories and a detailed explanation of the sampling techniques employed in recent inventories is in another USDA report (Goebel, 1992). For our study area the NRI estimates for 1982 and 1992 are based on USLE factor values for 1,945 sample points within the five sampled counties, and for 12,057 sample points within all 28 counties predominantly in MLRA 105.

Some Prior Applications

Wischmeier and Smith pointed out that the reason for having a systematic method for estimating rates of soil loss, such as the USLE or suitable alternative methods, is to rationalize decisionmaking for conservation planning on a site basis. The method enables planners to predict the magnitude of erosion under different climatic and soil conditions as well as alternative cropping systems, management techniques, and conservation practices (Wischmeier and Smith,1978,p.3). The USLE is used to estimate water-related sheet and rill erosion. Estimates of wind-associated soil erosion and of gully erosion induced by concentrated water flow involve other factors and methods.

In 1986 the Economic Research Service completed a national-level analysis of the erosion-control costs and benefits of the USDA's Conservation Technical Assistance, Great Plains and Agricultural Conservation Programs (Strohbehn,1986). The physical measures of sheet and rill erosion were based on the USLE; data for wind erosion were based on methods developed by Chepil and associates at USDA's Wind Erosion Research Unit at Manhattan, Kansas (Lyles,1985).

An application of the USLE methodology in assessing the physical and economic impacts of alternative soil conservation practices and policy options for reducing soil losses to given tolerance levels, has been completed for eight representative farms in southeast Minnesota that happen to be in MLRA 105 (Padgitt,1980). Prospective erosion control benefits for 448 conservation plans in 30 sampled counties in Alabama, North Carolina, South Carolina and Tennessee were analyzed by Grubb and Tolley (1966), using a preliminary version of the USLE.

A previous interdisciplinary study for a watershed in the Missouri loessial region in western Iowa predated the availability of the USLE, but was based on a similar rational soil loss formula, called the "Browning Factors" (Schwab with others,p.122ff). The objective of the Iowa team study was to apply engineering and agronomic principles in reconciling the economic interests

Anticipating the Universal Soil Loss Equation

The serious soil erosion problems observed in the early 1930's were the result of several factors: (1) Crop selection and land use methods not consistent with the capabilities of soils to produce sustained yields; (2) soil management problems specific to the area and indirectly if not directly related to potential erosion; (3) the absence of regular crop rotations where needed; (4) the practices (**P**). The estimated average annual erosion rate for a given cropping situation is then computed as:

A = R K L S C P

Definitions for each USLE variable are repeated from Wischmeier's and Smith's Handbook No. 537 (1978,p.4):

A is the computed soil loss per unit area, expressed in the units selected for **K** and for the period selected for **R.** In practice, these are usually so selected that they compute **A** in tons per acre per year, but other units can be selected.

R, the rainfall and runoff factor, is the number of rainfall erosion index units, plus a factor for runoff from snowmelt or applied water where significant.

K, the soil erodibility factor, is the soil loss rate per erosion index unit for a specified soil as measured on a unit plot, which is defined as 72.6 feet in length and having a uniform slope of 9 percent, continuously in clean-tilled fallow.

L, the slope-length factor, is the ratio of soil loss from the field slope length to that from a 72.6-ft length under identical conditions.

Regarding the cover and management factor C, the early soil surveys and Census reports

Productivity (LP) in Agriculture Handbook 537. In the rotations above, the greatest corn yield would be expected in the first year following meadow, the next highest in the second year following meadow, and lowest three or more years after meadow.

Tillage Systems

Modern conservation tillage technology did not exist in 1930. The moldboard plow was the primary tillage tool. In some cases where spring-planted crops followed corn, the land was disked to prepare the seedbed. Three general tillage alternatives were used at the time: (1) Fall moldboard plowing, with secondary tillage in spring, followed by seasonal cultivation as necessary for corn or other row crops; (2) spring moldboard plowing, secondary tillage and/or cultivation; and (3) spring disking.

Tillage systems for specific crops in 1930 involved various combinations of the three general types. Those chosen for this study appeared reasonable from the literature of the period and recollections of individuals familiar with agricultural methods of the time.

Selected 'C' factors for tillage options for each crop within rotations of varying length for Clayton County, Iowa as an example are given in table A-6. Note that the factors vary with the prior

The cover-management factors for corn sequences in the USLE calculations represent average conditions. They assume that 50% of the corn was harvested for grain with residues left, 40% was harvested for silage (residue considered removed), and 10% was grazed, either as a

Cropland and Crop Classifications

These were developed in this study to help match the soils in each county by land use capability class/subclass (LCC) to cropping sequence groups. The major land capability classes I, II, III and IV are generally usable for cultivated crops, but Classes II, III, and IV may have limitations such as erosion hazards (subscript e), excess wetness (subscript w), soil limitations

Table 4. Soils and crop groups by land use capabilities in sample counties in MLRA 105, 1930

Soil and Crop Groups	Clayton County, Iowa	Houston County, Minnesota	Winona County, Minnesota	Crawford County, Wisconsin	Vernon County, Wisconsin	Totals, 5 sample counties
Land Use Capability Classes and Subclasses, by Percent Used for Principal Crops[1]:						
Class I	90	65	70	90	60	76
Subclass IIe	90	65	70	90	60	71
Subclass IIw	90	44	45	60	35	50
Subclass IVe	60	35	45	36	30	35
Subclass IIs	60	35	45	36	35	48
Subclass IIIs	60	35	45	36	30	45
Subclass IVs	60	35	45	36	30	45
Subclass IIIe	81	45	61	65	46	64
County averages	79	47	62	45	39	55
Principal Crop Groups, by Land Use Capability Classes (data in acres) [2]:						
Crop Groups A and B:	58,000	43,800	79,700	10,3003	28,800	220,600
Class I, IIe	39,800	34,400	76,650	7,100	24,100	182,050
Subclass IIw	18,200	9,400	3,050	3,200	4,700	38,550
Crop Group C.	11,900	20,550	17,400	42,950	44,675	137,475
Subclasses IVe, IIs,	11,900	20,550	17,400	42,950	44,675	137,475
Crop Group D .	149,100	30,150	50,000	19,850	40,125	289,225
Subclass IIIe	149,100	30,150	50,000	19,850	40,125	289,225
All Groups/Uses,1930[3]	219,000	94,500	147,100	73,100	113,600	647,800
Vegetables	2,300	600	1,000	300	700	4,900
Irish potatoes	1,400	1,000	2,100	800	1,400	6,700
Tobacco	--	--	--	2,400	8,900	11,300
Corn	86,400	35,200	36,000	26,800	31,200	215,600
Small grains	75,500	35,800	74,600	26,100	47,800	259,800
Rotation meadow	53,400	21,900	33,400	16,700	23,600	149,000

[1] Percentages of total county acreages in given capability classes estimated as available for main crops in 1930.
[2] Acres have been estimated by applying the percentages above to all land in the given capability classes.[3] Crop acreages as reported in the 1930 Census of Agriculture and in some State crop reports for 1930.

Cropland Group AB

Cropland group AB was assumed suitable for A, minor row crops and B, relatively intensive or frequent corn production. Group AB included all Class I land and land use capability subclasses IIe and IIw. For example, in 1930 group AB included 58,000 acres in Clayton County, Iowa; 79,700 acres in Winona County, Minnesota; 28,800 acres in Vernon County, Wisconsin; and 220,600 acres in all five sample counties (table 4).

Group A--Minor Row Crops

Crop Group A included the minor row crops of Irish (white) potatoes, vegetables, and tobacco, assumed grown only on the best soils, with tobacco having first priority for the addition of barnyard manures. Of the five sample counties, for the most part tobacco was and is limited to Crawford and Vernon Counties in Wisconsin.

Again using Clayton County as an example, group A included the 2,300 acres vegetables and 1,400 acres of Irish potatoes, with half the acres in each alternated every other year with either corn or any small grain. This means that about 1,850 acres of corn and also 1,850 acres of small grains were estimated as rotated with the minor row crops in 1930, of which 1,150 acres were alternated with vegetables and 700 acres with potatoes. Details on such allocations are illustrated for Clayton County in table A-7. A total of 7,400 acres of the 58,000 acres of cultivatable cropland in capability class I and subclasses IIe and IIw in cropland group AB were required for the rotations involving vegetables and potatoes, leaving 50,600 acres available for rotations of corn with small grains or meadow.

Group B--Intensive Corn

Continuous corn was ruled out in the analysis. According to the literature of the period few farmers grew corn on the same land from year to year. On all soils continuous corn would seriously deplete the organic matter, especially considering that crop residues were normally removed. It is probable that farmers periodically put their best corn land into meadow or small grains.

For crop group B for all five sample counties, a standard set of three crop rotations was initially considered, the first being CCCMM, a rotation mentioned in the Crawford County, Wisconsin soil survey as common on valley lands. Two other rotations considered possible for Group B were CCCGM and CG. The three rotations were taken as initial candidates for allocating available cropland, other than that needed for Group A (potatoes, vegetables and tobacco), among corn, small grains. and meadow.

As crop groups A and B involve the same capability classes (class I, subclasses IIe and IIw), their crop allocations were combined as shown for Clayton County, Iowa in the first row of table A-7. The 58,000 acres in these soils were estimated to have included the 2,300 acres in vegetables and 1,400 acres in potatoes, plus 29,310 acres in corn, 20,670 acres in small grains, and 4,320 acres of rotation meadow.

Group C--Two-crop Small Grain/Meadow Rotations

Crop group C lands represented situations where steep slopes or other limitations such as shallow soils generally prohibited the culture of any corn, even that in rotation with meadow, recalling the earlier conclusion that few effective supporting conservation practices were in place in 1930. In the literature examined, one rotation prominently mentioned for this case was GGMM. Another was GGM. These were selected as starting points for reconstructing probable 1930 rotations involving only small grains with meadow.

Cropland group C restricted to small grains and meadow included land use capability subclasses IVe and IIs, IIIs, and IVs (table 4, table A-7). It included 11,900 acres for Clayton County, our example, and 137,475 acres for the five sample counties combined. Allocating all these soils in Clayton County to a GGM rotation, which apparently was the most common rotation followed throughout the five sample counties, indicates that there were about 7,933 acres in small grains and 3,967 acres in meadow.

Group D--Three-crop Corn/Small Grain/Meadow Rotations

Crop group D allowed a wider array of possible crop combinations and crop sequences, which also varied among the five sample counties. Group D involved only cropland in capability subclass IIIe---about 149,100 acres for Clayton County and 289,225 acres for the five counties (table 4). The leading three-crop rotation was CGM, as one year of corn followed by a year in oats or other small grain, followed by one year of clover or other meadow crop, but with it having been seeded in with the small grain nurse crop.

The CGM rotation was mentioned as frequently followed in nearly every soil survey or erosion report researched. Further, it seems to have had wide use throughout the region, given that it was a primary rotation tested against fallow on research plots at the Conservation Experiment Stations at Clarinda, Iowa; Bethany, Missouri; and La Crosse, Wisconsin.

In reviewing the history of the Clarinda Station, Browning recalled that the farm purchased for the Station site had been under cultivation for more than 75 years, was tenant-operated, and was generally in a run-down condition, with corn having been grown about 75 percent of the time, and with no sign of conservation practices that would help reduce soil and water losses (Browning,1948,p.12). In another report of the period Uhland indicated that for a three-year CGM rotation on Marshall silt loam soils at Clarinda, average annual runoff was only 31 percent that for continuous corn, and average annual soil losses were only 18 percent those for continuous corn (Uhland,1949,p.2).

The research farm at the La Crosse, Wisconsin Station had also been cultivated for about 75

Steps in Deriving USLE Erosion Rates for 1930

Carrying through the allocation procedures described to all five sample counties and arriving at USLE estimates of erosion losses on cultivated cropland involved five general steps. These could be followed in similar studies for other areas. The first four were critical in estimating the cover-management factor **C** with regard for crops grown, rotations possibly followed, and the tillage or residue management practices used.

Step 1-- Defining Crop and Rotation Groups: Match the soils in each county by land use capability class/subclass to cropping sequence groups. As indicated earlier the rotations having high values of **C** could be assumed more likely on the better soils, while rotations having lower **C** values were more likely to have been followed on soils having greater erosion hazards and more limitations for production.

We assumed that in the period 1925-35 the rotations involving minor row crops and intensive corn production (crop groups A and B) occurred mainly on the soils in land use capability subclasses I, IIe, and IIw. Group C sequences (two-crop small/grain/meadow rotations) were assigned mostly to capability subclasses IVe, IIs, IIIs, and IVs. Three-crop corn/small grain/meadow rotations (Group D) were assigned to the capability subclass IIIe lands.

Step 2--Estimating Available Cropland: Determine from modern soil surveys for Clayton and other sample counties (Kuehl,et.al.,1982) the total acres of each soil or land use capability class suitable and needed for the principal crops in each county.

Step 3--Estimating Principal Crops by Soils: Estimate the percent of each soil type or capability class devoted to the principal crops in 1930, and calculate corresponding acreages. Adjust the estimates as needed to balance the calculated acres to the acres of cropland reported in the 1930 Census of Agriculture. Completing steps 1, 2 and 3 produced the information in table 4.

Step 4--Matching Crops and Rotations to Soils: Estimate the percentage of each soil or capability class devoted to each crop rotation. Distribute accordingly the acres for each crop given in table 4. Adjust the rotation acres as needed to balance to the 1930 reported acres of each crop. Such adjustments could involve: (a) changes in the relative percent of the various rotations, or (b) alternative rotations.

Step 5--Other Factors and Calculations: To this point the acres in each combination of soils and rotations were determined and the USLE factors **K**, **L**, **S**, and **C** could be assigned to each rotation and cropping sequence. Values of the rainfall and runoff factor **R** for each county were taken from Agriculture Handbook No. 537.

Soil scientists provided values for **K, L,** and **S** from soils data. Values for **K, L,** and **S** depend on the characteristics of the soil map units which comprise each soil group.

Values for the cover-management factor **C** in the USLE, for the various crop rotations and management systems, were provided by agronomists. Appendix table A-6 is an abridged list of **C** values for cropping sequences applicable to this study for MLRA 105.

Supporting conservation practices such as contour farming and terraces were not in general use in 1930. Therefore, for the purposes of this study, the support practice factor **P** was assumed to have a constant value of 1.0. The final calculations are then--

(a) **R** x **K** x **LS** x **C** x **P** = average annual gross erosion rate, in tons per acre per year

(b) Average annual soil loss per acre x acres = <u>total</u> average annual soil loss in tons per acre for each combination of soils and rotations;

(c) The sum of soil losses for all the combinations in step (b) = average annual soil loss, in <u>tons per year</u>, for the total cropland acres in the county or other area concerned.

Steps 1 to 5 were repeated for each sample county. Consolidated results for the five sample counties are in table 5. A weighted average annual soil loss rate of 14.9 tons/ac/yr under 1930 conditions was thus determined for the five sample counties as a group. This was the rate compared with the average annual erosion rate of 5.5 tons/ac/yr expected under 1992 conditions for the same group of five counties as estimated in the 1992 National Resources Inventory.

Erosion in Sample Counties, 1930, 1982 and 1992

Some brief background may be helpful here. The physical significance of soil loss is determined by the extent to which soil productivity in source areas is impaired and the landscape damaged from gullies, as well as the fate of any soil removed--whether it may be redeposited downfield , or transported to become accumulated or suspended sediment in other areas, structures or water courses. The relationships involved have recently been examined by Beach (1994) in three Minnesota basins within MLRA 105.

The complex processes were described earlier by Trimble and Lund in their research in the Coon Creek Basin:

> ". . . . . material eroded from upland slopes has three immediate routes: It can be deposited within the basin either as colluvium or as alluvium, or it can be transported directly out of the basin to provide immediate sediment yield. Material deposited as colluvium can later be

The economic consequences have similar dimensions. They include the cost of lost production potential in source areas and the costs associated with unnecessarily cleaning ditches or replacing roads, bridges and other structures. These rather ordinary and traditional economic costs become mingled with broad ecological implications for economic institutions and the natural environment. Preserving the beauty of rural areas, maintaining water quality, and assuring adequate current farm income while assuring a productive agriculture for future generations are all laudable goals. They argue for evaluation and balance within an ecological framework.

Comparisons in this study of cropland soil erosion between 1930, 1982 and 1992 in MLRA 105, an area of about 18,860 square miles (12+ million acres) and involving the major parts of 28 counties in four States, were limited to 'gross' soil erosion or on site displacement. The physical or socioeconomic consequences in the two periods are not examined, although they are reflected qualitatively in the gross rates for the area in principal crops.

Also evaluated were productivity-decreasing or 'excess' rates of erosion. The excess rate is defined as the gross rate of detachment in source areas, in tons per acre per year, less the rate 'T' at which losses could occur without impairing long term productivity and without applying additional fertilizers or other soil additives.

Information on cropland areas and acres of principal crops planted in 1930 and 1992 were available from the Census of Agriculture, supplemented where necessary from historical files in State statistical offices. Similar though not completely parallel information on cropland uses for

briefly, the areas in cropland/crop group AB were allocated first to subsistence or minor cash row crops like potatoes, vegetables and any tobacco. The remaining AB land was considered available for relatively frequent corn in association with some small grains and rotation meadow. Crop group AB includes land use capability class I, and subclasses IIe and IIw. The group included about 220.6 thousand acres or 34 percent of the cropland used for principal crops in 1930. The top section of table 4 shows the percentage of each land use capability subclass suitable for crops in each sample county. The controlling or officially reported crop acreages for 1930 are listed in the bottom section.

Crop group C includes lands in capability subclasses IIs, IIIs, IVs and IVe. In 1930 group C accounted for about 137.5 thousand acres or 21 percent of the area in principal crops (table 4). This group was generally restricted to small grains and meadow. Group D includes all subclass IIIe land. It involved 289.2 thousand acres or 45 percent of the 647.3 thousand acres used for principal crops in the five sample counties in 1930. These is the area where most of the corn was likely grown, in various combinations with small grains and meadow.

The detailed assignments for 1930 of crops and rotations among the land use capability and crop groups of table 4 are illustrated for one county (Clayton County, Iowa) in table A-7.

Sample County Results

Besides Clayton County the sample counties included Houston and Winona Counties in Minnesota, and Crawford and Vernon Counties in Wisconsin. Expected average annual USLE soil erosion rates under 1930 conditions were computed for each designated soil or soil complex (soil map unit) classified as to land use capability in each of the five sample counties, considering further the crop sequences and rotations fitted to each mapping unit. Sets of USLE calculations were made for 437 map units, ranging from 81 map units for Winona County, Minnesota to 102 map units for Vernon County, Wisconsin (table 5).

The results of this process were then pooled for the five sample counties (table 5). Expected annual erosion rates under 1930 conditions were generally highest for crop groups C and D. The estimated USLE erosion rates for 1930 were greatest for the capability subclasses where susceptibility to erosion was the main limitation (IIe, IIIe, and IVe), regardless of whether these areas were used for row crops or small grain rotations with meadow.

Under the distributions of various soils and crops grown in 1930, the average erosion rate on cropland in principal crops ranged from 9.1 tons/ac/yr in Winona County, Minnesota to 22.4 tons/ac/yr in Crawford County, Wisconsin. The estimated mean across all soils and crops in the five sample counties was 14.9 tons/ac/yr. The standard error of the mean for the 437-member series of USLE rates for each differentiated soil map unit in the area in 1930 was about 0.5 ton/ac/yr, for a relative error of 3.5 percent (table 5).

Table 6 compares cropping patterns and erosion conditions between 1930 and 1992 in the five sample counties. Erosion rates in 1930 ranged from 8.5 tons/ac/yr on the best soils used for row crops (crop group AB) to 18.4 tons/ac/yr on crop group C, as the vulnerable soils generally restricted to small grains or meadow. Rates were nearly as high (18.2 tons/ac/yr) for crop group D, as the capability class IIIe land used for various corn/small-grain/meadow rotations. Group D accounted for about 54 percent of the gross soil loss in the five counties but for 45 percent of all land in row crops, small grains or meadow. This appears to be the case even though a substantially lower share (36 percent) of cropland group D land was devoted to row crops than was the land in cropland group AB (56 percent). Rates of soil loss under 1982 and 1992 conditions across all row crops, small grains and rotation meadow for the sample counties were accessed from the National Resources Inventory. The NRI estimates for 1982 and 1992 are based on USLE factor values for 1,045 NRI sample points erosion rate between 1930 and 1992 occurred despite large absolute and relative increases in row crops (216 thousand acres or 91 percent). The gain in row crops was achieved by expanding (by 14 percent) the total area suitable for all crops, by greatly reducing (by 80 percent) the area in oats and other small grains, and by applying recommended soil conservation measures.

Table 7 sums up the sample county analysis for 1930 and 1992. The respective erosion rates

Table 5. Soil loss rates by crop groups and land use capability subclasses, sample counties, 1930

Crop groups and LCC[1]	Share of total crop land	Clayton County Iowa	Houston County Minnesota	Winona County Minnesota	Crawford County Wisconsin	Vernon County Wisconsin	Average for five counties
	Percent	Estimated soil loss rate in 1930, tons/ac/yr					
Group AB	34.1	8.2	9.4	7.7	8.0	9.9	8.5
Class I	3.3	3.0	3.0	3.6	3.6	3.4	3.3
Sc IIe	24.8	11.0	11.4	8.4	10.5	11.9	10.0
Sc IIw	6.0	6.2	3.4	2.8	4.6	2.9	4.7
Group C	21.4	9.1	21.4	19.1	22.0	16.1	18.5
Sc IVe	19.6	14.8	22.5	22.5	23.1	16.2	20.1
Sc IIs	0.7	0.7	1.0	0.9	1.0	0.8	0.8
SC IIIs	0.4	0.7	1.5	0.9	1.1	0.5	0.9
SC IVs	0.7	2.6	1.6	1.4	2.1	0.8	2.2
Group D	44.5	20.1	15.3	7.8	30.8	19.9	18.2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 6. Principal cropland uses and soil erosion in 1930 and 1992 in five sample counties in MLRA 105*

Cropland and groups	Share of crop acres	Cropland in group	Soil loss rate per acre[4]	Gross soil loss per year	Distribution of crops by groups		
					Row crops	Small grains	Meadow
	Percent	1,000 ac	Tons/ac/yr	1,000 tons	1,000 ac	1,000 ac	1,000 ac
Principal Crops, 1930 total	100	647	14.9	9,654	238	259	150
			(Percent)	(100)	(37)	(40)	(23)
AB: Minor row crops/intensive corn[1]	34	220	8.5	1,871	125	76	19
			(Percent)	(20)	(56)	(35)	(9)
C: Small grains/meadow[2]	21	138	18.4	2,534	9	80	49
			(Percent)	(26)	(7)	(36)	(57)
D: Corn/small grains/meadow[3]	45	289	18.2	5,249	104	103	82
			(Percent)	(54)	(36)	(36)	(28)
Principal Crops, 1992 total	100	756	5.5	4,172	454	51	251
			(Percent)	100	(61)	(6)	(33)
Increase or decrease, 1930-1992	--	109	9.4	5,482	216	-209	102
	(Pct. change)	(14)	(63)	(57)	(91)	(-80)	(68)

* Sample counties: Clayton County, Iowa; Houston and Winona Counties, Minnesota; Crawford and Vernon Counties, Wisconsin.

[1] Group AB includes potatoes, vegetables or tobacco rotated with corn or small grains, with the remaining land devoted to frequent corn, with some small grains or meadow. Group AB includes areas in land use capability Class I and subclasses IIe and IIw.

[2] Group C generally restricted to small grain and meadow cropping. Group C includes areas in land use capability subclasses IIs, IIIs, IVs and IVe.

[3] Group D includes rotations including corn, small grains and meadow, all on capability subclass IIIe land.

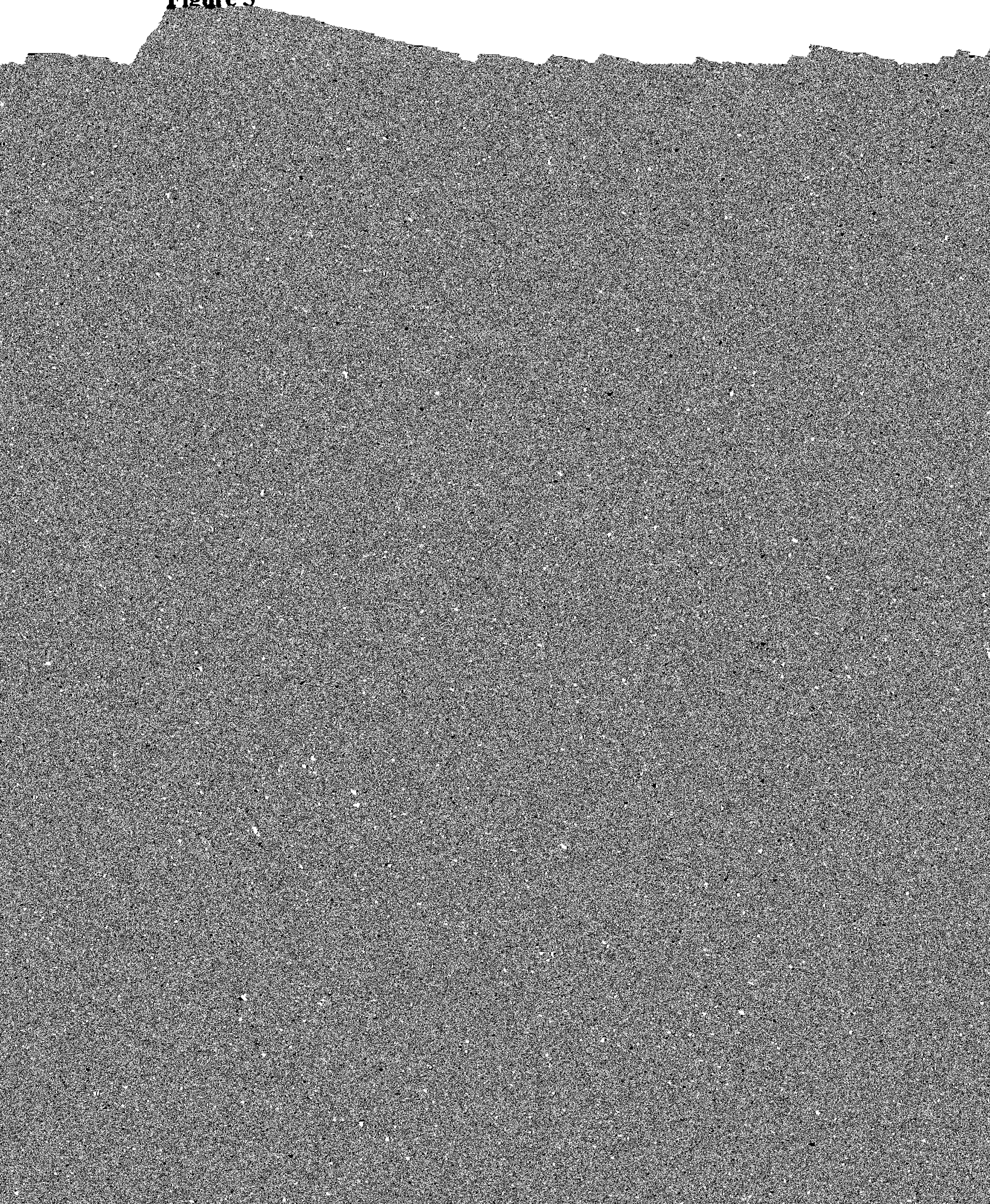
[4] Soil loss rates for 1930 evaluated by crops grown on the land use capability classes indicated. Soil loss rate for 1992 is for all crop groups combined, from USDA's 1992 National Resources Inventory.

Table 7. Cropland erosion in 1930 and 1992 for five sample counties in MLRA 105

Items	Item	Units	1930	1992	Percent change, 1930-1992
1. Principal crops (Census)	Estimate	1,000 ac	647.0	756.1	17
	(Error)	(1,000 ac)	(13.5)	(18.1)	--
2. USLE erosion rate (NRI)	Estimate	Tons/ac/yr	14.9	5.5	-63
	(Error)	Tons/ac/yr	(1.0)	(0.8)	--
3. Gross erosion, average/yr	Estimate	1,000 tons	9,654	4,172	-57
	(Error)	(1,000 tons)	(848)	(704)	--
4. Lower limit, erosion/yr	Estimate	1,000 tons	8,806	3,468	* -45
Upper limit, erosion/yr	Estimate	1,000 tons	10,502	4,876	** -67

The share for meadow, which had become mostly alfalfa by 1992, rose from 28 percent of all land in principal crops in 1930 to 33 percent in 1992. Between 1930 and 1992 the total area in row

Figure 5

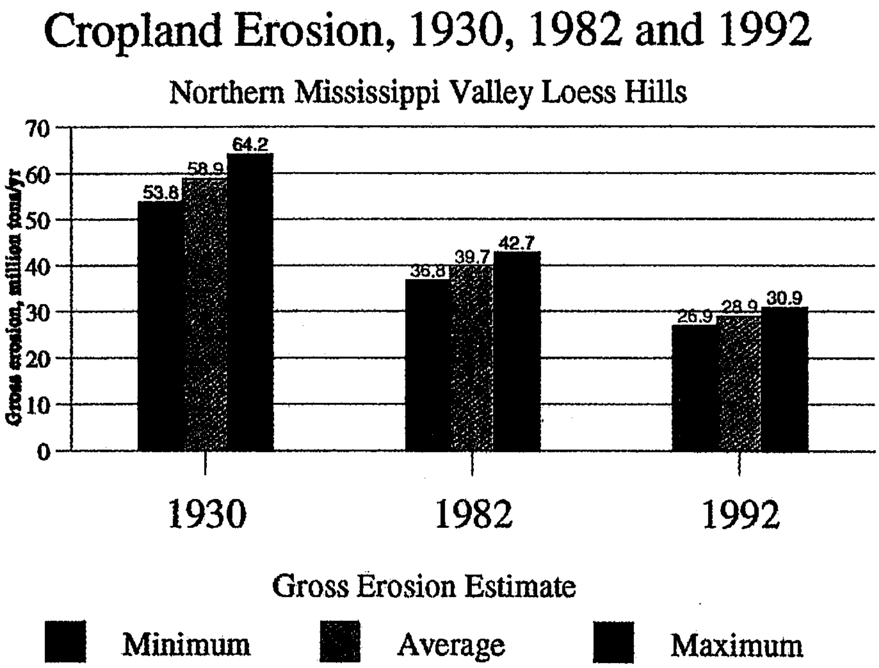


Results of the analysis of erosion conditions in 1992 versus 1930 for the Northern Mississippi Valley Loess Hills are given for the five sample counties in table 7 and then for all 28

Figure 6

Erosion Quantities 1930, 1980 and 1992

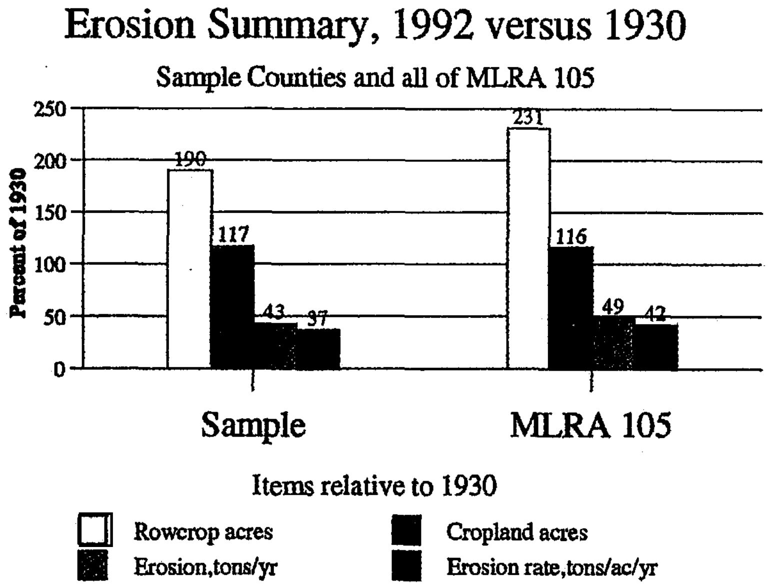
Figure 7



Productivity-Decreasing Erosion

The erosion analysis for MLRA 105 also examined the extent to which erosion in the three periods 1930, 1982 and 1992 could be considered to adversely affect long-term soil productivity. While any erosion is generally undesirable and regarded as 'excessive', excess erosion from a productivity standpoint was evaluated in this study as the amount by which gross erosion rates per acre exceeded allowable tolerances. The 'excess' rate of erosion was defined as the gross rate of

Figure 8



subclasses within each cropland/crop group for each sample county, thus obtaining overall rates per acre of erosion in excess of assigned T values.

The results of the analysis of erosion rates and volumes greater than **T** for 1930 are given in table 9 for each of the eight land use capability subclasses and the three major cropland/crop groups defined for each sample county. The rates greater than **T** are averaged across all subclasses and crop groups in the counties but across only the cropland that was eroding at gross rates greater than **T** in 1930. The overall rate in excess of **T** in 1930 for the five sample counties (11.9 tons/ac/yr) and its corresponding gross USLE rate per acre for the individual areas eroding at rates greater than **T** (16.7 tons/ac/yr) were extrapolated to the region in calculating total amounts of gross as well as productivity-decreasing erosion.

By 1992 the <u>cropland area</u> eroding at rates greater than **T** and losing productivity in 1930 had less than 5 tons/ac/yr for about 36 percent of the lands in MLRA 105 that were eroding at rates greater than 'T' in 1992. A T-value of 5 tons/ac/yr is frequently cited as the tolerance appropriate for most loessial soils in the Midwest.[13]

Soil displacement expressed in inches of surface soil removed per year or over extended periods was the measure commonly employed in early studies of erosion processes. In some respects it is easier to visualize than the weight displaced. At the risk of appearing overly precise an illustration can be given. Using a weight of 142 tons per acre-inch of soil as an approximate conversion constant (Uhlman,1949,p.2), total erosion per acre (16.7 tons/ac/yr) on the cropland eroding in excess of **T** in 1930 was equivalent to 0.12 inches (3 mm) per year. The excess or productivity-decreasing erosion rate in 1930 (11.9 tons/ac/yr) would amount to 0.08 inches (2.1 mm) per year. By 1992 total soil displacement had been reduced to 13.4 tons/ac/yr, equivalent to 0.09 in/yr (2.4 mm/yr). The portion associated with the gradual loss of productivity (8.9 tons/ac/yr) was equivalent 0.06 in/yr (1.6 mm/yr).

The increments of soil removed in a given year may be hardly if at all noticeable but they assume major importance if continued. A gross erosion rate of 16.7 tons/ac/yr (0.111 in/yr) continued over 25 years amounts to nearly 3 inches of topsoil displaced, or to nearly 6 inches if continued for 50 years. An average gross rate in 1930 in Crawford County, Wisconsin, one of the to about 29 million tons per year. That on the cropland that had been eroding at rates greater than **T** in 1930 fell by 40 percent. The tons of erosion causing productivity to decline was reduced by 62 percent between 1930 and 1992, or from about 41 down to 16 million tons per year.

The essential results of this study have been illustrated in figure 8: Under conditions in

Table 8. Cropland erosion in 1930, 1982 and 1992 in 28 counties predominantly in the Northern Mississippi Valley Loess Hills (MLRA 105)

					Percent changes

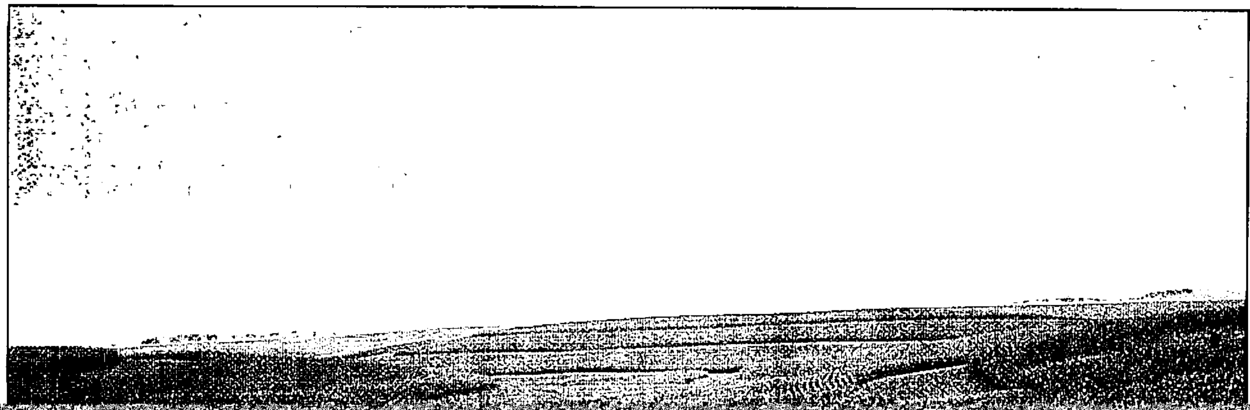
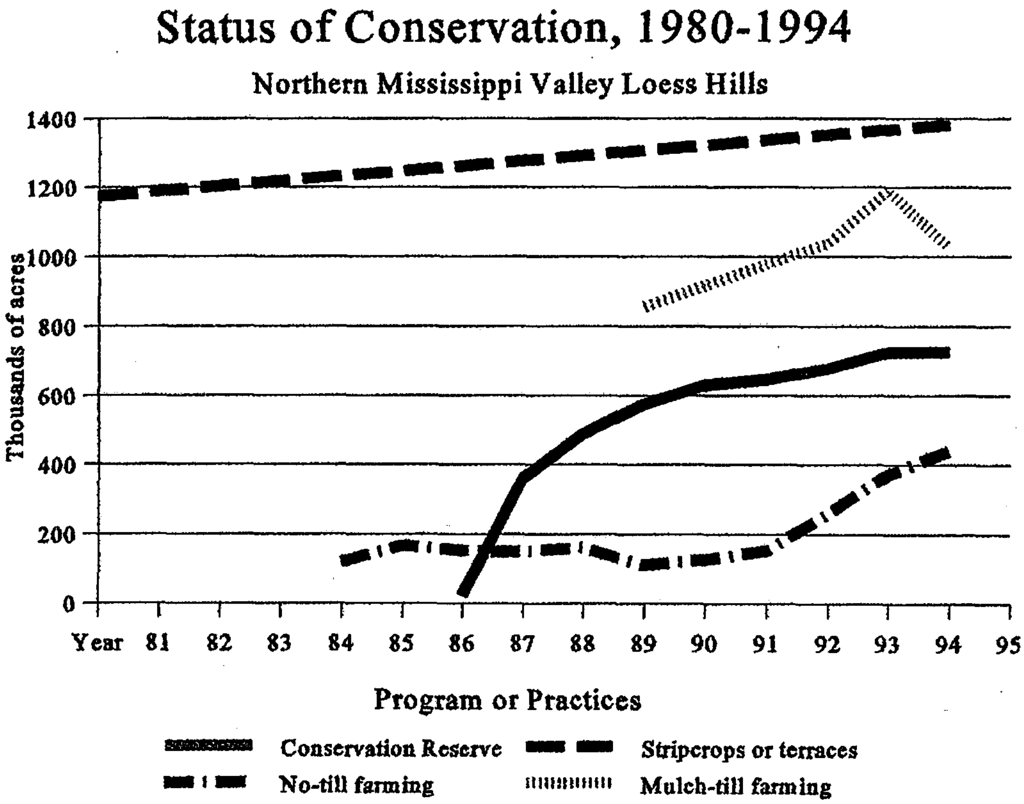


Figure 9



and Wisconsin pay an average of 52 percent of the total cost of onfarm conservation practices. State and local agencies cover 8 percent, for a nonfederal total of 60 percent and a Federal share of 40 shield the soil surface from impact and runoff, including ...

Table 9. Soil loss rates in excess of 'T' by crop groups and land use capability subclasses for sample counties, 1930

Crop groups and LCC[1]	Clayton County Iowa	Houston County Minnesota	Winona County Minnesota	Crawford County Wisconsin	Vernon County Wisconsin	Average for all counties	Cropland eroding above 'T'
Estimated excess rates of soil loss in 1930, tons/ac/yr							Percent
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]